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Reliability and Validity of the Repeatable Battery for Assessment of Neuropsychological Status Scale in Evaluation of Vascular Cognitive Impairment in Elderly Han Population

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ABSTRACT

Introduction: Vascular cognitive impairment (VCI) and Alzheimer's disease are the most common cognitive impairment diseases in the elderly. This study aimed to apply the Repeatable Battery for Assessment of Neuropsychological Status (RBANS) scale to evaluate VCI in elderly patients and analyze its reliability and validity.

Methods: We enrolled 278 VCI patients admitted to our hospital, from June 2017 to June 2018. The basic clinical information of each patient was documented, and the Mini-Mental State Examination (MMSE) and the RBANS scales were suggested to complete.

Results: We found significant correlations between the RBANS total score and age, diabetes, hypertension, coronary heart disease and years of education. The internal consistency of the RBANS scale Cronbach α suggested a good agreement with the total score and the single score at two time points. Moreover, the RBANS total score and the score of each dimension in the RBANS scale were positively correlated with the MMSE immediate memory, calculation ability, delayed memory, commanding ability, reading comprehension ability, command execution, sentence making, and pattern duplicating ability.

Conclusion: In conclusion, the RBANS has good reliability and validity for the assessment of cognitive dysfunction in elderly VCI patients. It can be used as a routine clinical and research tool, for the simplicity in operation and superior acceptance.

Keywords: RBANS scale, MMSE scale, vascular cognitive impairment, cognitive impairment, elderly patient

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INTRODUCTION

Vascular cognitive impairment (VCI) and Alzheimer's disease are the most common cognitive impairment diseases in the elderly. VCI was proposed by Bowler et al. at the end of the last century (1), which was developed on the concept of multi-infarct dementia (2). VCI is a heterogeneous group of cognitive disorders that share a presumed vascular cause (3–5). Stroke is one of the major causes of VCI (6). Currently, the scales for cognitive measurement and VCI diagnosis for the elderly include the Mini-Mental State Exam (MMSE) and the Montreal Cognitive Assessment (MoCA) (7). However, the two scales are too simple and partially overlapped and can only be used as a preliminary evaluation or screening method. The Repeatable Battery for Assessment of Neuropsychological Status (RBANS) is a set of neuropsychological state screening scale designed by Randolph 20 years ago. It is widely used to assess the neuropsychological function of people aged 20 to 89 years, due to its simple operation and comprehensive testing dimensions (8). Although RBANS has been shown to be a useful tool in evaluating the cognitive status of patients with dementia (9), stroke (10), schizophrenia (11), Parkinson's diseases (12) and post-acute traumatic brain injury (TBI) (13), no study has applied the RBANS in VCI patients. Our study aimed to evaluate VCI in elderly patients using the RBANS and analyze its reliability and validity.

Highlights

- **To evaluate VCI in elderly patients using the RBANS.**
- **RBANS can be used as a routine clinical and research tool.**
- **RBANS has the characteristics of simplicity in operation and superior acceptance.**

METHODS

Patients

Our study was approved by the Ethics Committee of our hospital (approval number KY2014-051-01). We enrolled the patients who met

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the VCI diagnostic criteria admitted to the Department of Neurology of our hospital from June 2017 to June 2018. Clinical Trial registration number: NCT02350283.

The inclusion criteria were: 1) cerebrovascular events (such as a history of cerebral infarction or cerebral hemorrhage) more than 2 months ago, with cognitive impairment associated with cerebrovascular events; 2) age 65 to 85 years; 3) having received brain imaging examinations, such as CT and MRI; 4) willing to participate in this survey and had signed informed consent.

Exclusion criteria were: 1) participants failed to have the ability to communicate and write; 2) disorders of consciousness or paralysis; 3) history of mental illness or epilepsy; 4) depression history (Comell depression table score ≥8 according to the Diagnostic and Statistical Manual of Mental Disorders, 4th Edition, DSM-IV); 5) Alzheimer's disease or other types of dementia (such as the Hachinski scale score ≤4, or those met the Alzheimer's disease diagnostic criteria from the National Institute of Neurology, Language Communication Disorders and Stroke – Alzheimer's Disease and Related Diseases Society, Lewy body disease, or other dementia diagnosed by the DSM-IV criteria); 6) cognitive impairment caused by head trauma; 7) an obvious poor general condition, severe aphasia, or neurological deficits that prevented the patients from receiving cognitive function tests; 8) other diseases that could explain the cause of dementia, such as Parkinson's disease, normal pressure hydrocephalus, carbon monoxide poisoning, hypoglycemia, demyelinating disease, tumor, liver and kidney dysfunction, and hypothyroidism; 9) alcoholism or psychotropic drug abuse; 10) serious vision or hearing impairments.

Data Collection

The basic clinical information of each patient was documented, including: 1) general information (gender, age, and years of education); 2) disease data: diabetes, high blood pressure, or other coronary heart disease, and the detailed course of disease; 3) other information like smoking years.

Cognitive Evaluation

The RBANS was performed twice (14). The first evaluation was performed on the first day of the study, and the second evaluation was performed in the eighth week after the first evaluation.

The RBANS (form A) was administered according to the standard instructions. The RBANS is a widely used neuropsychological battery with excellent psychometric properties. The test includes 12 subtests that tap the following cognitive domains: attention, visuospatial function, verbal learning (list-learning and prose passage), verbal recall, and psychomotor speed. Subtest scores were converted to standard scores using the normative tables in the manual, and a total standard score was determined (Randolph, Tierney, Mohr, and Chase, 1998).

Statistical Analysis

All data were analyzed using the SPSS 22.0 software. The correlations were analyzed between the RBANS scores (total score and scores of each dimension) and age, years of education, diabetes, hypertension, coronary heart disease, and smoking years. If the correlation coefficient is statistically significant, a partial correlation analysis was performed. The Cronbach α coefficient was used to test the internal consistency of the first evaluation and that 8 weeks later. The validity of the MMSE and the RBANS scales were calculated using the Pearson correlation analysis. P<0.05 was considered statistically significant.

RESULTS

A total of 278 VCI patients were included in our study (Table 1). The total MMSE score of our patients was 23.67±5.48, and the maximum possible

Table 1. Patient demographic information (n=278)

Age, year	63.5±8.2
Male, n (%)	67.2%
Years of education	8.1±5.3
Diabetes, n (%)	28.7%
Hypertension, n (%)	42%
Smoking years	21±9.9
Coronary heart disease, n (%)	27%

Table 2. Scores of the repeatable battery for assessment of neuropsychological status

	Patients (n=278)	Possible score range
Total score	137.23±27.02	53–120
Immediate memory	27.14±6.03	49–120
Spatial structure	26.93±4.83	53–131
Speech function	23.20±6.03	57–134
Attention function	29.73±12.99	46–135
Delayed memory	23.78±9.22	44–129

Table 4. Cronbach α coefficient of the RBANS scale and correlation coefficient (r) of two time points

Items	Cronbach α coefficient	r
Immediate Memory	0.85	0.72**
Visual Span	0.89	0.67**
Speech Function	0.72	0.61**
Attention	0.69	0.84**
Delayed Memory	0.83	0.77**
Total Score	0.87	0.88**

**P<0.01.

Table 3. Correlation between RBANS scores and age, sex, and years of education

	Age#		Smoking years#		Diabetes†		Hypertension†		Coronary heart disease†		Years of education#	
Items	CC	PCC	CC	PCC	CC	PCC	CC	PCC	CC	PCC	CC	PCC
Total score	-0.721**	0.464**	0.173	0.092	-0.602**	-0.387**	-0.399*	-0.153	-0.243*	0.119	0.781**	0.613**
Immediate memory	-0.423**	-0.401**	-0.023	-0.036	-0.347*	-0.490**	-0.243*	-0.097	-0.173	-0.123	-0.347*	0.490**
Visual span	-0.626**	-0.119	0.238*	-0.091	-0.273*	-0.271*	-0.253*	-0.113	-0.273*	-0.113	-0.273*	0.271*
Speech function	-0.423**	-0.166	0.074	-0.147	-0.334**	-0.288*	-0.037	0.055	0.066	0.031	-0.134	0.388**
Attention	-0.234*	-0.353**	-0.034	-0.077	-0.258*	-0.203	-0.148	0.083	-0.071	0.009	0.158	0.603**
Delayed memory	-0.457**	-0.663**	0.018	0.118	-0.651**	-0.553**	-0.259*	-0.103	-0.289*	-0.263*	0.254*	0.553**

CC, correlation coefficient; PCC, partial correlation coefficient.
#Pearson's correlation analysis; †Spearman's correlation analysis.
*P<0.05, **P<0.01

Table 5. Correlation between RBANS* and MMSE** scores

	Total Score	Immediate Memory	Visual Span	Speech Function	Attention	Delayed Memory
MMSE Total Score	0.831**	0.871**	0.488**	0.298*	0.732**	0.682**
Time Orientation	0.320	0.309*	0.188	0.019	0.134	0.782**
Location Targeting	0.082	0.222	0.198	0.122	0.238	0.293*
Immediate Memory	0.603**	0.334*	0.493*	-0.203	0.412*	0.560**
Calculating Ability	0.837**	0.731**	0.577**	0.193	0.698**	0.649**
Delayed Memory	0.588**	0.332*	-0.045	0.122	0.586**	0.712*
Commanding Ability	0.492*	0.438	0.076	0.322	0.321*	0.200
Tongue Twister	0.199	0.331*	-0.133	-0.204	0.273	0.488*
Reading Comprehension	0.601*	0.404*	0.207	0.345*	0.622**	0.449*
Command Execution	0.498**	0.381*	0.720**	0.128	0.331*	0.389*
Sentencing	0.332*	0.281	0.497*	0.289*	0.310*	0.444*
Pattern Duplicating Ability	0.246*	0.619**	0.578**	0.033	0.659**	0.712**

*P<0.05; **P<0.01

score is 30. The total RBANS score of our patients was 137.23±27.02 (Table 2). We found significant correlations between the RBANS total score and age, diabetes, hypertension, coronary heart disease and years of education (Table 3). The partial correlation analysis revealed that the total score of RBANS was negatively correlated with age and diabetes, and positively correlated with years of education. Specifically, the immediate memory was negatively correlated with age and diabetes, and positively correlated with years of education; the visual span was negatively correlated with diabetes and positively correlated with years of education; the attention ability was negatively correlated with age and positively correlated with years of education; the delayed memory was negatively correlated with age, diabetes, and coronary heart disease, and positively correlated with years of education.

The internal consistency of the RBANS scale Cronbach α is shown in Table 4, which suggested a good agreement with the total score and the single score at two time points (the baseline and 8 weeks later).

The MMSE scale was used to determine whether the RBANS scale was equivalent to the criterion of cognitive function. For all the 278 subjects, the RBANS total score and the score of each dimension in the RBANS scale were positively correlated with immediate memory, calculation ability, delayed memory, commanding ability, reading comprehension ability, command execution, sentence making, and pattern duplicating ability of the MMSE. And the scores of different RBANS dimensions were related to some individual scores of the MMSE scale (Table 5).

DISCUSSION

Currently, there are increasing needs for stroke care, and the proportion of cognitive impairment in elderly patients after stroke is 64% (15). The most commonly used scales to assess the neurological function of VCI patients are the MMSE and the MoCA, which have some known limitations. An earlier study in acute stroke has indicated that the MMSE is less capable of testing complex cognitive impairments in domains such as visuospatial, executive function and abstract reasoning. In addition, Dong's research indicated that the MMSE is less sensitive in detecting VCI after acute stroke (16). Moreover, the MoCA scale performs well in detecting true positivity but it is imprecise in the detection of true negative findings in Schizophrenia (17). Instead, the RBANS is a relatively concise and comprehensive, single-individual testing scale that includes five dimensions: instant memory, visual span, speech function, attention ability, and delayed memory. It takes 30 to 40 min for the elderly to complete the entire test, which ensures that patients would not feel fatigued. All subjects in our study successfully completed the scale.

Our study confirmed that the RBANS has good reliability and showed a high consistency among three reviewers. Except for the graphic recall that may be affected by subjective factors of the subjects, the criteria for other projects are highly objective. For longitudinal comparison, the repeated measurements of the RBANS also exhibited good agreement. For instance, the repeated measurement reliability of the total score reached 0.88, and that of each dimension varied from 0.61 to 0.84. This finding could also be supported by some independent studies worldwide (18, 19).

The RBANS scale for the VCI patients has good validity. The MMSE is useful for studying deteriorations of cognitive abilities as an index of dementing diseases progression and the effect of pharmacological and non-pharmacological interventions. Consequently, it is well established not only as a screening tool broadly used in research and clinical settings but also for repeated application (20). In our study, the MMSE was used as a criterion for correlation analysis. It is currently the most widely used scale for assessing neuropsychological function, which includes immediate memory, speech function, spatial structure, attention, orientation, and calculating ability.

Our results showed that the RBANS total score and the MMSE total score were positively correlated, as well as the score in each dimension. We found that each specific score in the MMSE (including immediate memory, calculating ability, delayed memory, commanding ability, reading comprehension, command execution, sentence making, and pattern duplicating ability) were positively correlated with the RBANS total score. In addition, the scores in multiple dimensions of the RBANS were correlated to most of the specific scores in the MMSE scale. These findings suggested that the RBANS had a good parallel validity.

Another interesting finding of our study was that the total score of RBANS was correlated with age, diabetes, and the years of education. Among them, age is an independent influencing factor of VCI (21), for that prevalence of cognitive dysfunction after stroke increases with age (22). Diabetes is also an independent risk factor for VCI (23), with a most obvious relationship to post-stroke cognitive dysfunction (24). Moreover, the year of education was a protective factor for VCI, which was also consistent with previous findings (22).

Our study has some limitations. Firstly, the RBANS is completed by only one tester independently, which may lead to subjectivity in the judgment of graphic memory. Secondly, the RBANS has 4 forms: A, B, C, and D. Our study only carried out analysis with the A form. Thirdly, the raw scores of RBANS rather than the age-based scaling tables were used, which may involve the correlation with age. Finally, the sample size of our study was small, and further studies are needed.

In conclusion, the RBANS has good reliability and validity in assessment of cognitive dysfunction in elderly VCI patients. It can be used as a routine clinical and research tool, for its simplicity in operation and good acceptance.

Ethics Committee Approval: Our study was approved by the Ethics Committee of our hospital (approval number KY2014–051–01).

Informed Consent: Patients who signed informed consent participated in this study.

Peer-review: Externally peer-reviewed.

Author Contributions: Concept- CyZ; Design- CyZ; Supervision- YmD, DmL; Resource- XL; Materials- QyS, XpY; Data Collection and/or Processing- YhZ, BY; Analysis and/or Interpretation- LgS, XL; Literature Search- CyZ, YmD, DmL, QyS, XpY, YhZ, BY, LgS, XL; Writing- CyZ; Critical Reviews- CyZ, YmD, DmL, QyS, XpY, YhZ, BY, LgS, XL.

Conflict of Interest: None.

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